Aqua-Net: An Underwater Sensor Network Architecture

Design, Implementation and Initial Testing

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Outline

- Motivations
- Aqua-Net
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- Case Study
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Motivations

- System architecture is application specific
- New implementation is time consuming
- Difficult to re-use existing code
- Hard to compare and evaluate performance

What is Aqua-Net

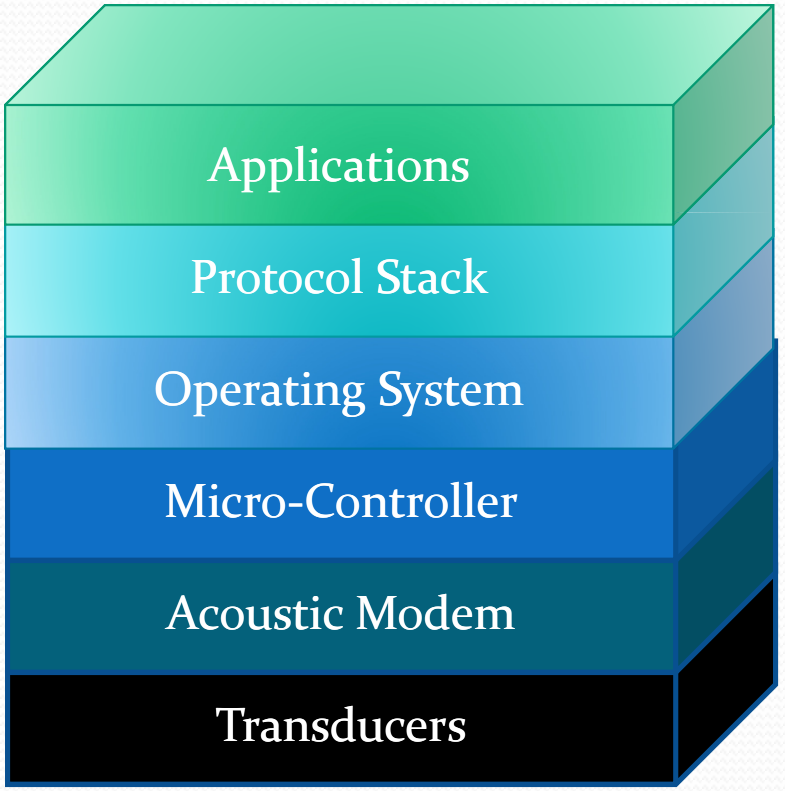
- A framework for Underwater sensor networks (UWSN)
- A set of standard interfaces for developers
- Make it easier to implement
  - Protocols
  - Applications
- Design philosophy
  - Lowering the “Narrow Waist”
  - Cross-layer design
  - User-friendly

Aqua-Net Features

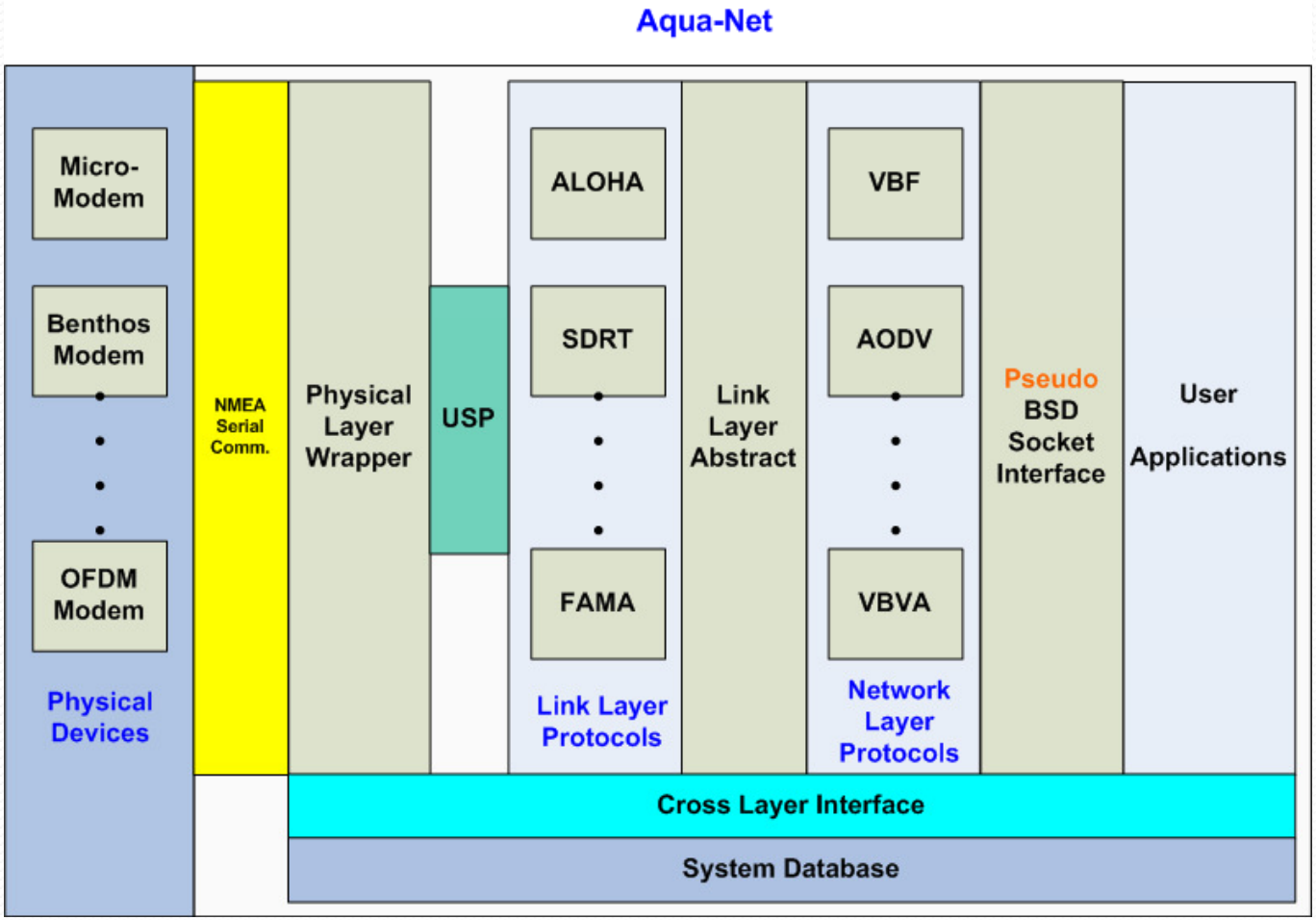
- Easy to
  - Modify an existing protocol
  - Add a new protocol
- Developer friendly
  - Socket style (TCP/IP)
  - Implemented in user space
- High
  - Reusability
  - Portability

System Components

- Hardware platform
  - Acoustic modem
    - Micro-modem, Benthos modem, OFDM modem, etc.
  - Micro-controller
    - Gumstix
- Software platform
  - Operating system
    - Embedded linux
  - Network protocol stack
  - Interfaces and protocols



Protocol Stack



Hardware Platform

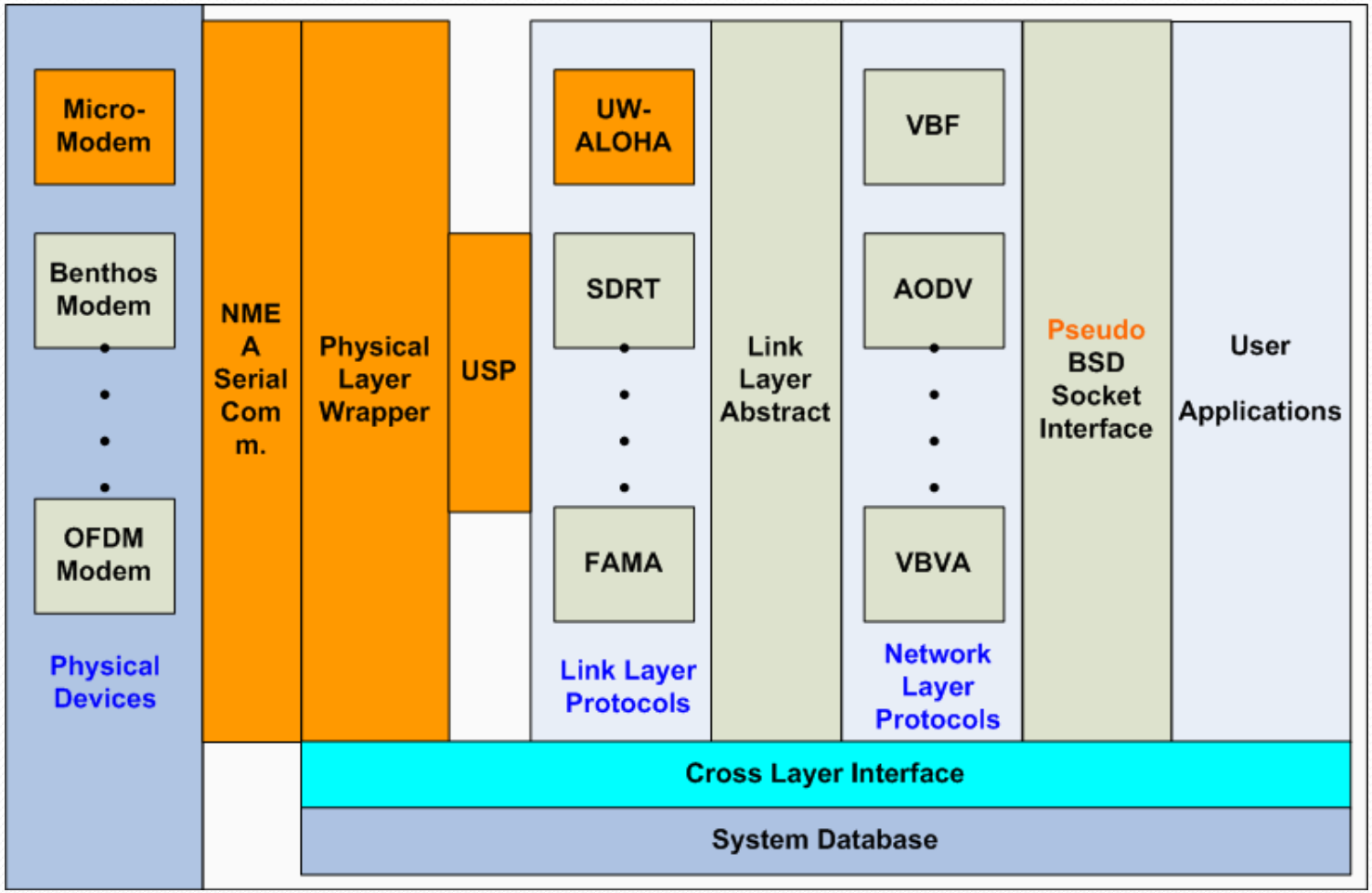
- Gumstix

Processor:	XScale™
Speed:	up to 600MHz
Memory:	up to 128MB RAM up to 32MB Flash
Features:	Serial port USB support Audio support LCD support CCD camera signals
Operating system:	Embedded Linux, etc.
Size:	80mm x 20mm

Operating System

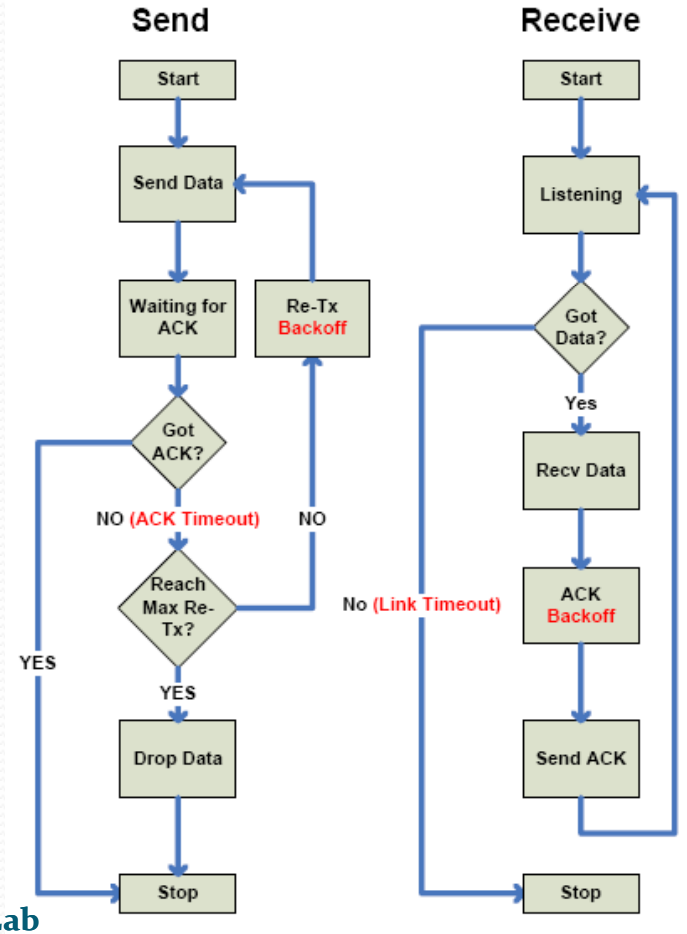
- Embedded Linux
  - Designed and optimized for embedded system
  - Well supported by open source community
    - Linux kernel
    - Applications
    - Development tools
  - Widely used in commercial products
    - Mobile phones
    - Game consoles
    - Video cameras

Case Study: UW-Aloha



UW-Aloha

- Traditional Aloha
  - Doesn't work in UWSN
- Underwater Aloha (UW-Aloha)
  - Effective back-off scheme
  - Automatic repeat-request (ARQ)
- UW-Aloha work flow



UW-Aloha Back-off Schemes

- Binary exponential back-off

  $T_{bk}=(2^{i}-1) \times t_o$

  i: number of retransmissions

  t_o: minimal frame time

- Poisson back-off

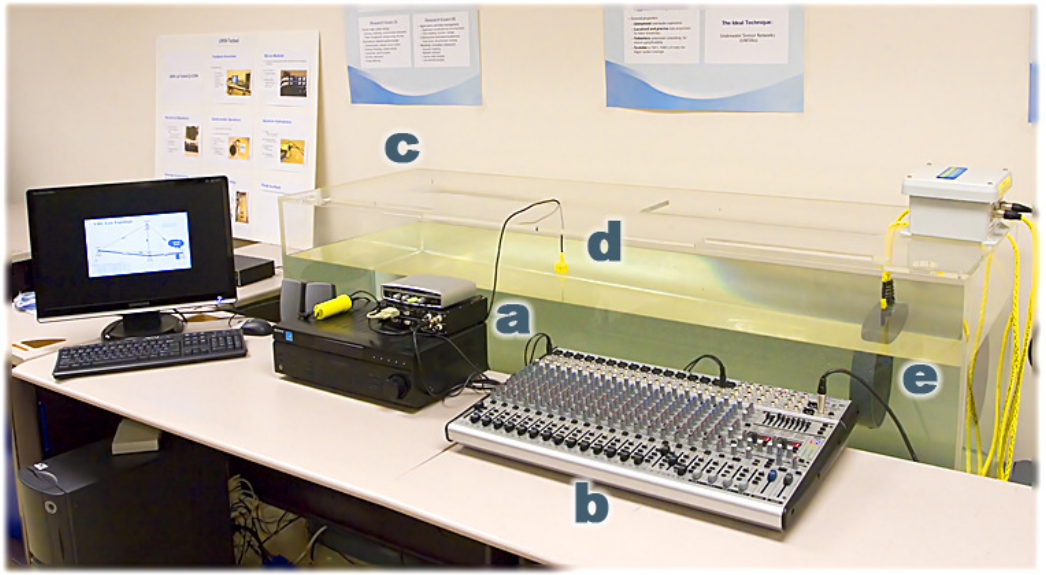
  $T_{bk}=-\lambda^{-1} lnU$

  λ: traffic load

  U: random variable, uniform on (0,1)

Lab Test Setup

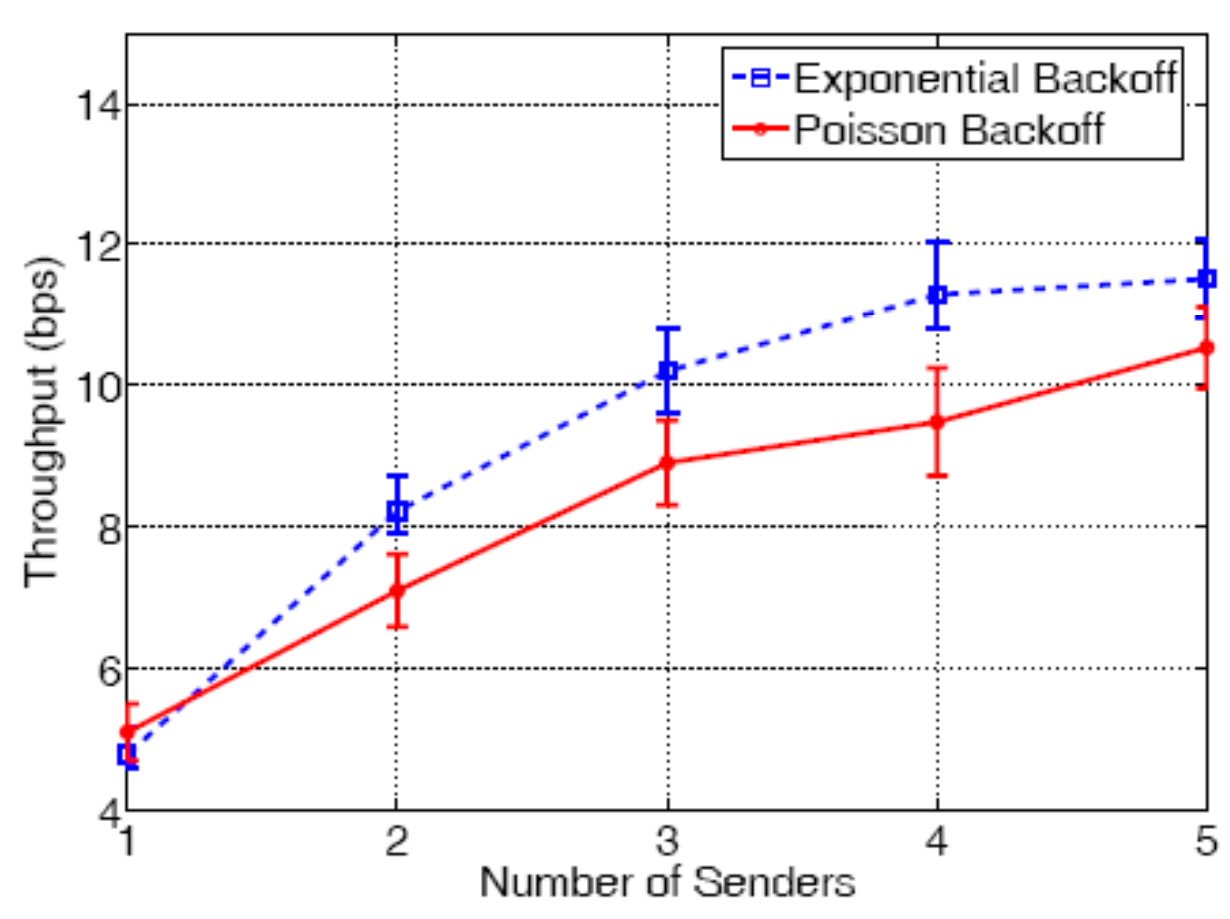
- Topology:
  - One hop network
  - Multiple sources
  - Single sink
- Testing environment
  - Aqua-Lab
    a. Micro-Modem
    b. Sound mixer
    c. Water tank
    d. Hydrophone
    e. Underwater speaker



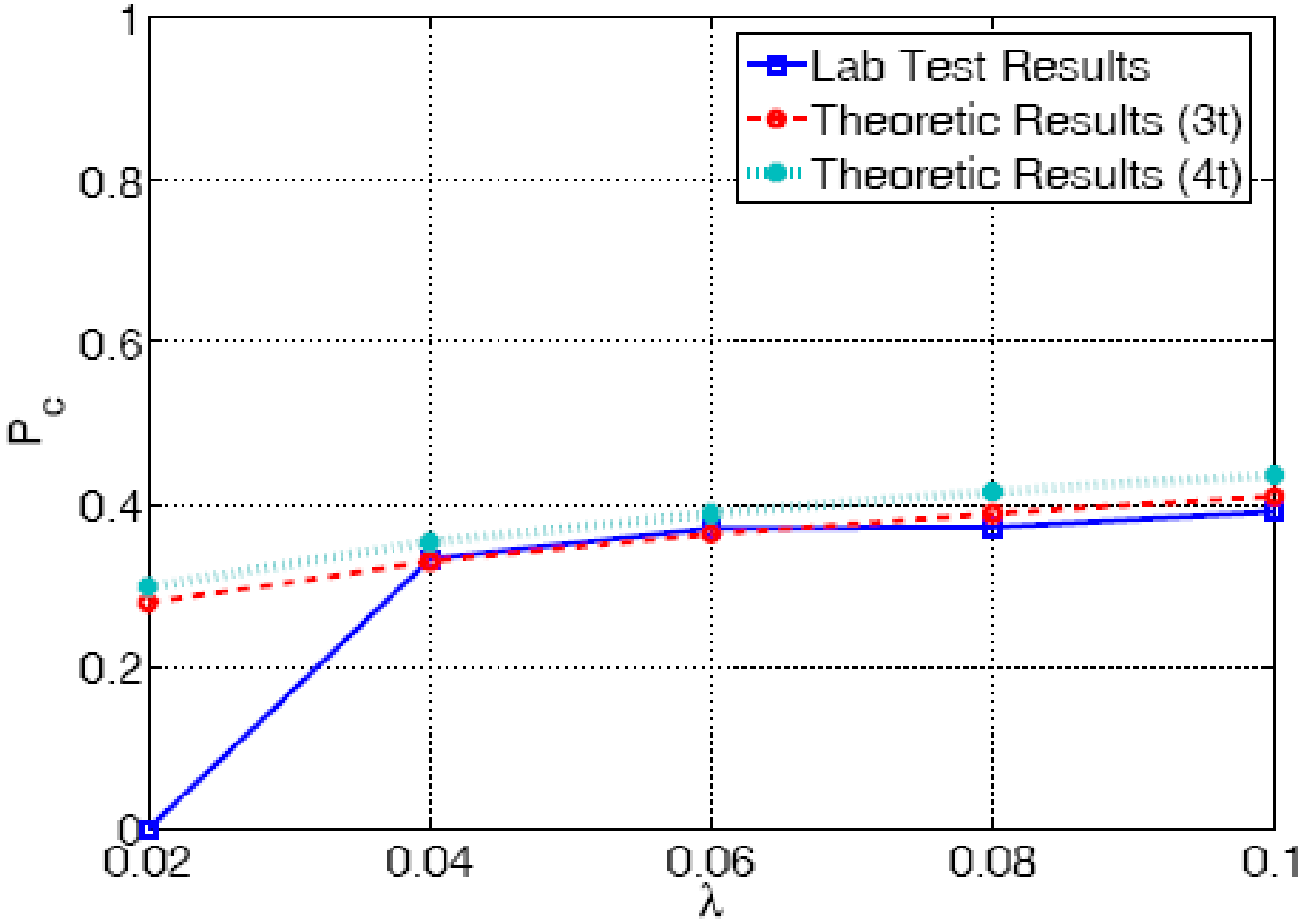
Lab Test Setup (cont.)

- Parameters:
  - Sending rate: 80 bps
  - Frame size: 32 bytes
- Testing scenarios
  - Increasing total traffic by increasing sending nodes

Performance



Theoretical *vs* Lab Testing Results



Conclusions

- Aqua-Net
  - Developer/User friendly
  - Robust & Reliable
  - Extendable & Configurable
  - Cross-layer design possible
  - Tested in many field trials

- Future work
  - Include more protocols
  - Support new techniques

Thanks!